SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1910.

GENERAL PHYSICS.

207. *Instrument for Determining Co-ordinates.* **A. Wagener.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 2086–2089, Dec. 18, 1909.)—The instrument described in this paper is designed to accurately determine the co-ordinates of points on any given diagram. Essentially it consists of a straight metal bar, which is graduated and also has a V-shaped groove cut along its upper face; another graduated bar carrying a microscope has a wheel at one end and two-point contact in the groove of the first bar, so that it is at right angles to, and can move parallel to, the first bar. The first bar being placed parallel to one axis of any diagram, the readings corresponding to the origin of co-ordinates are obtained on the two bars, and hence the co-ordinates of any other point can easily be obtained, correct to at least 0·1 mm. For constructional details the original paper must be referred to. A. W.

208. *Electrical Device for Solving Algebraic Equations.* **A. Russell.** (Electrician, 64. p. 528, Jan. 7, 1910.)—A description of this apparatus has previously been given [Abstract No. 1484 (1909)]. The real roots of equations are found at once by the device, but in order to find the imaginary roots several algebraic transformations have first to be made. C. N. Haskins has communicated to the author a method by which, in the important case of a bi-quadratic, the imaginary roots can be found almost at once by the very simple form of the Wright device required to solve a cubic equation. Take the equation $ax^4 + 4bx^3 + 6cx^2 + 4dx + e = 0$, and suppose all the roots are imaginary. Writing $(y/a - b/a)$ for x the equation becomes—

$$y^4 + 6Hy^2 + 4Gy + a^2I - 3H^2 = 0,$$

where H, G, and I have the usual meanings. The roots of this equation must be of the form $\lambda \pm \iota\mu_1, -\lambda + \iota\mu_2, -\lambda_1 - \mu_2$. Now the quantities $\theta_1 = \lambda^2$, $\theta_2 = -(\mu_1 + \mu_2)^2/4$, $\theta_3 = -(\mu_1 - \mu_2)^2/4$, which are all real, are the roots of

Euler's equation $4\theta^3 + 12H\theta^2 + (12H^2 - a^2 I)\theta - G^2 = 0$. The three roots of this equation are found immediately by the Wright device, and thus λ^2, $(\mu_1 + \mu_2)^2$, and $(\mu_1 - \mu_2)^2$ are found. Hence all the imaginary roots of the given bi-quadratic can be written down at once. A. W.

209. *Apparatus for Determination of very small Differences of Pressure.* **A. Lafay.** (Comptes Rendus, 149. pp. 1115–1117, Dec. 13, 1909.)—The usual method of measuring small differences of gaseous pressures by means of the deformation of membranes of caoutchouc, &c., is inconvenient, owing to the variations in the elasticity of the membranes. In the apparatus described a silvered membrane of collodion is made by allowing a thin film of this material to dry upon a silvered glass plate. On peeling off the membrane the silver layer completely adheres to it, and the membrane is a good conductor of electricity. By charging the membrane electrostatically it can readily be deformed in either direction. The method of working is a zero one. When the membrane has been deformed by a slight increase of gas pressure, the electrostatic charge necessary to restore it to its original position is measured, from which the gas pressure can be calculated. The movements of the membrane are optically observed by a simple interference method. E. C. C. B.

210. *A Small Balance.* **J. Carpentier.** (Comptes Rendus, 150. pp. 74–76, Jan. 10, 1910.)—A balance made by Collot is described. After having opened the case of the instrument to introduce the body to be weighed, the case is closed and the adjustment of weights is done from the outside by mechanism passing through the case. Advantages claimed are: (1) The weighing takes place without agitation of the air and consequent convection trouble; (2) double weighing is used; (3) the beam carries in all cases 100 gm. at each extremity, so that the weighing is independent of any deformation of the beam, or of change in sensitiveness of the balance. P. E. S.

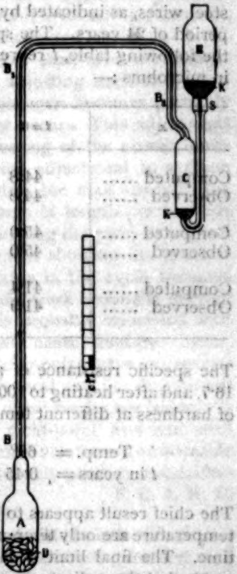
211. *Sounding Tubes.* **C. E. Munroe.** (Chem. Engin. 10. No. 2. Chem. News, 101. p. 17, Jan. 14, 1910.)—Deals with the method of coating the sounding tubes used in Kelvin's method. Burrill's method gives coatings which only react sluggishly with sea water, and which are apt to detach themselves from the tube. The following method gives better results. The coating liquid consists of 100 gm. of Le Page's liquid glue, to which is added, with stirring, first 8·4 gm. of finely powdered silver nitrate, and then 1·95 gm. of finely powdered potassium chromate, the mixture being stirred with a glass rod until the bright red colour is developed to its maximum brilliancy throughout the mass. This quantity will coat ten dozen tubes. After thoroughly cleaning and drying the tubes, the mixture is sucked up them for a length of about 10 cm., the tubes being then inverted to allow the excess liquid to flow down the tube. About 24 hours is required for hardening, and then, after capping, the tubes are ready for use. Prepared in this way the tubes are coated evenly with a translucent brilliant red coating, which reacts instantly on contact with salt water, the colour being sharply and immediately discharged to the height to which the water has risen within the tube. They are very sensitive, and will remain so if stored in a cool, dry place, out of contact with the light; but if they are heated or exposed to direct sunlight the colour changes and the sensitiveness decreases. The process is so simple that it may easily be carried out on board ship. A. W.

212. *Atomic Volume of Allotropic Modifications at very Low Temperatures.* **E. Cohen** and **J. Olie, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 437–445, Dec. 28, 1909.)—Contrary to a previous suggestion [Abstract No. 124 (1907)], it is shown that the atomic volumes of different allotropic modifications of carbon and tin do not converge to the same value as the absolute zero is approached, the ratios of the specific gravities at different temperatures being as follows :—

Temperature.	Ratio. Sp. Gr. Diamond/Sp. Gr. Graphite.	Ratio. Sp. Gr. White Tin/Sp. Gr. Grey Tin.
18°	1·585	1·266
− 88°	1·583	—
− 164°	1·582	1·274

For the specific gravity determinations at low temperatures a combination of dilatometer and weight-thermometer has been used of the form shown in the Fig., where A is a 20-c.cm. reservoir, and B, B_1, B_2 a capillary of 0·7 mm. bore, the capacities of C and E being 6 and 20 c.cm. respectively. A weighed quantity of the substance under examination is introduced into A, the capillary then sealed on, and the whole filled with pentane to a mark near B_2, the shaded part KK being filled with mercury. The expansion for a known rise of temperature is determined by the rise of mercury above the ground-glass junction S into E.

W. H. St.



213. *Apparatus for Testing Aeroplane Models.* **C. E. Larard** and **R. O. Boswall.** (Engineering, 88. pp. 777–779, Dec. 10, 1909.)—The apparatus recently installed at the Northampton Institute, London, is described. A double gantry with upper guard-rails about 60 ft. long, is provided with a carriage to which experimental planes can be attached ; the carriage is towed by means of a cord running over a pulley, the motive power being a falling weight. A rotating drum and tuning-fork apparatus is arranged to record results, from which velocities and accelerations may be deduced, the period during which the model plane rises off the gantry rails being recorded on the same graph by means of an electrical attachment. A specimen graph and the results deduced therefrom are given.

C. A. B

214. *Mechanical Testing of Indiarubber.* **K. Memmler** and **A. Schob.** (Königl. Materialprüfungsamt, Mitt. 27. 4. pp. 178–227, 1909.)—It is impossible in an abstract to give more than a survey of the ground covered by this lengthy investigation. The material used was sheet rubber 6 mm.

thick. The effect of the shape of the test-piece upon the results as regards breaking strength is examined, and in particular the question of the ring-shaped sample *versus* the ordinary test-piece shape. The apparatus employed for stamping out the samples is illustrated and the results are set forth in numerous tables and curves. It is concluded that even more comprehensive tests are required in order that the characteristic extension curve for india-rubber may be determined with certainty. The growth in extension appears in general to decrease with increasing load. The duration of the loading appears to exercise a great effect on the values for the breaking strength and elongation. A number of samples showed, when kept loaded for 30 min., a breaking strength only half that obtained with rapid loading. The elastic after-effect differs very greatly in different samples, and hence the simple tensile test should be supplemented by tests on the permanent extension and the elastic after-effect. With the exception of a single sort of rubber, all the rubbers tested by the ring method showed a diminution in the strength and elongation when they had been loaded previous to testing. L. H. W.

215. *Secular Softening of Hard Steel.* **C. Barus.** (Phys. Rev. 29. pp. 516–524, Dec., 1909.)—The author gives some results on the tempering of hardened steel wires, as indicated by determining specific resistance, observed over a period of 24 years. The spontaneous softening of three wires is indicated in the following table, *t* representing time in years and *s* the specific resistance in microhms :—

s.	$t=0$	3·1	12·2	24·0 years.
Computed	44·8	41·1	38·1	36·0
Observed	44·8	40·6	38·1	36·1
Computed	45·0	41·2	38·2	36·0
Observed	45·0	40·7	38·2	36·1
Computed	41·4	37·8	33·9	31·7
Observed	41·9	36·5	34·2	32·9

The specific resistance of a wire after exposing to 330° C. for 1½ hours was 16·7, and after heating to 1000° C., 15·0. The times taken for equal diminutions of hardness at different temperatures are as follows :—

Temp. =	66°	100°	185°	330°
t in years =	0·45	0·36	0·10	1 min.

The chief result appears to be that the limits of temper corresponding to any temperature are only temporary if the experiments are conducted for a limited time. The final limit is the soft state which can, apparently, be ultimately reached at the ordinary temperature, although after an enormously long time. [See also Abstract No. 3 (1910).] F. C. A. H. L.

216. *Elastic Limits of Iron and Steel under Cyclical Variations of Stress.* **L. Bairstow.** (Roy. Soc., Phil. Trans. 210. pp. 35–55, Dec. 9, 1909. Proc. Ser. A. 82. pp. 483–485, July 31, 1909. Abstract.)—The author has carried out experiments on three samples of iron and steel of varying composition with the object of confirming Bauschinger's theory of fatigue, compression

being regarded as negative stress, and the elastic limits in tension and compression as "superior" and "inferior" elastic limits respectively. Bauschinger's theories may be generalised as follows: "The superior limit of elasticity can be raised or lowered by cyclical variations of stress, and at the same time the inferior limit will be raised or lowered by a definite, though not necessarily equal, amount. The range of stress between the limits has therefore a value depending only on the material and the stress at the inferior elastic limit. This elastic stress range is equal to the max. range of stress which can be repeatedly applied to a bar without causing fracture." The plan of the research has been to carry out observations of the length of the specimen under the conditions of fatigue testing. By plotting extensions as ordinates against stresses as abscissæ throughout the cycle, "hysteresis loops" are obtained. The max. width of the loop measured parallel to the extension axis gives the "cyclical permanent set." For equal stresses no permanent extension occurs and the hysteresis loop is quite closed, any change in the specimen being shown by the production of cyclical permanent set—an increase in the extension during each cycle. With unequal stresses the loop is not quite closed and the cyclical permanent set is accompanied by a very small change of length. When the max. stress is high the hysteresis loop becomes very small and the superior elastic limit is raised by extension. The hysteresis loop retains the same general character for all ratios of maximum and minimum stress. The results show that, after a sufficient number of repetitions, iron or steel is capable of adjusting itself to cyclical variations of stress, after which adjustment the specimen becomes perfectly elastic throughout the cycle and fatigue does not occur. This adjustment becomes possible because of the raising and lowering of the elastic limits under the action of repeated stresses. During the adjustment to a given cycle of stress, a change of length occurs, even when the max. stress in the cycle is less than the static yield-stress. This change of length corresponds to the extension in an ordinary tensile test on exceeding the yield-stress, and the increase of elastic limit is greatest in specimens showing the greatest extension during adjustment. If the range of stress in the cycle becomes sufficiently great, the specimen becomes inelastic and work is done in moving portions of crystals relatively to each other, and is probably associated with slip-lines which develop into cracks and ultimately cause fracture. Since, however, observations taken almost to the breaking-point gave no special warning of deterioration, the damage is evidently local and the slips do not increase in extent due to repetitions. The precise effect producing fracture is therefore somewhat obscure. Below the static yield-point iron and steel appear to be capable of maintaining an unstable condition for a considerable time against cyclical variations of stress which ultimately produce a considerable change of length. F. C. A. H. L.

217. *Stress Distribution during Tension Tests.* **C. A. M. Smith.** (Engineering, 88. p. 796, Dec. 10, 1909.)—In making tension tests axial loading is of utmost importance, for if a circular specimen be loaded eccentrically part of the material is subjected to a greater stress than that obtained by dividing the area of the specimen into the total load. The spherically seated grips, though preferable to the wedge grips, do not ensure axial loading, while the assumption that as soon as the load is applied they automatically line up, neglects the friction of the seat. The author shows that unless the load is very eccentric the grips will not move on applying the load, the eccentricity of loading necessary to cause movement being independent of the diam. of the specimen, but directly proportional to the radius of the spherical seat. If the radius of the spherical seat be 1½ in. and the coefficient of friction 0·1, the load can be eccentric by 0·15 in. before the seats will move. The ratio of maximum to mean stress is given by the formula $1 : 1 + 8/d$, where δ is the eccentricity of the load and d the diam. of the specimen, and in the above case with a 1-in. specimen is at least 2·2. An actual case showed a ratio of 2·96. The ratio of maximum to mean stress is generally greater during tension tests than compression tests. F. C. A. H. L.

218. *Resistance of Steels to Repeated Alternate Stresses.* **J. E. Howard.** (Mech. Eng. 24. pp. 828–829, Dec. 31, 1909. Paper read at Congress of the Internat. Assoc. for Testing Materials, Copenhagen, 1909.)—After the presentation of a few results of a series of tests conducted on six grades of open-hearth steel ranging from 0·17 to 1·09 per cent. carbon, the behaviour of steel under different conditions of test is discussed. Diagrams are given indicating the number of repeated alternate stresses of different magnitudes which caused rupture of the several experimental shafts. The relative endurance of each of two grades of steel when subjected to different stresses is shown in these diagrams. As the stresses are increased in magnitude, and approach in value the tensile elastic limit of the steel, there is shown a rapid decrease in the endurance of the material. The limiting stress for indefinite endurance—if remaining intact after several hundred million repetitions may be so designated—is very much below the tensile elastic limit. A noteworthy feature of the tests is the superior endurance displayed by the steels containing 0·78 and 0·82 per cent. carbon. C. O. B.

219. *Report on Cast-iron Test Bars.* **A. F. Nagle.** (Amer. Soc. Mech. Engin., Journ. 31. pp. 1057–1063, Mid-Oct., 1909.)—From the author's examination of tests bars for castings he arrives at the conclusion that the test bar is not to be regarded with too much confidence as indicative of the exact strength of the casting. For the results upon which this conclusion is based the original must be referred to. L. H. W.

220. *Flexibility of Wire Ropes.* **R. W. Chapman.** (Engineering, 89. p. 25, Jan. 7, 1910.)—In making experiments on the flexibility of wire ropes two qualities are met with, viz., the flexibility, and the internal friction of the rope. If a wire rope be bent within its elastic limit, it does not return to its original position on removing the stress, because of internal friction. These properties can be shown by clamping one end of a short wire rope and applying a deflecting force at the other end. The force is caused to gradually reach a max. value, then to diminish to zero, and to reach a max. value in the opposite direction, and so on until the cycle is completed. Throughout the cycle measurements of the deflection are made, and the results plotted in a diagram, when a closed curve somewhat resembling a hysteresis curve is obtained. Its area is a measure of the internal friction of the rope and the inclination of its central line a measure of the flexibility. By thoroughly lubricating the rope a narrower diagram of the same inclination is obtained. In this way a direct comparison of the flexibilities and internal frictions of two ropes may be obtained. F. C. A. H. L.

221. *Pratt's Hypothesis and Variations in Gravity.* **F. R. Helmert.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 48. pp. 1192–1198, 1909.)—In a previous communication [Abstract No. 27 (1909)] the author showed how the depth of the level surface (Ausgleichsfläche) of equal pressure could be calculated from the variations of gravity from the normal values at places near the steep ocean coast of a continent. The necessary data have now been collected and discussed, and the details are given in the present paper. The calculated depth is 118 ± 22 km., which is in very good agreement with the results 114 and 122 km. obtained by Tittmann and Hayford by other methods. A. D. R.

222. *Determination of Gravity Acceleration near Bordeaux.* **E. Esclangon.** (Comptes Rendus, 150. pp. 139–142, Jan. 10, 1910.)—Biot and Matthieu, and later Collet, have shown that anomalies occur in this region. The reversible and inversible pendulum of Defforges is used in a vacuum of 11 mm. of mercury. Paris is the central station for timing and comparison, Floirac is the intermediate station, and five stations north and east of Bordeaux were used. Using Bouguer's formula for reducing for altitude, all the five stations give anomalous results, *i.e.*, acceleration is less than expected, the stations on high plateaux showing less anomaly than the two stations near the coast to the north of Bordeaux. The latter gave results 980·644 and 980·640 respectively, whereas Bouguer's formula would indicate 980·694 and 980·688 respectively. P. E. S.

223. *Photographs of Flight of Shot.* **F. Neesen.** (Phys. Zeitschr. 10. p. 968, Dec. 1, 1909. Paper read before the 81. Naturforscherversamml., Salzburg.)—The great heights which balloon-artillery must be able to reach necessitate an extension of the range tables, and so photographic reproductions of the flight of shot, although affording little information as to velocity, are of particular interest. Two photographs are given with the present paper, the first showing the path of a shot which emits smoke, the second showing the end of the flight of five luminous shot from a mountain gun. The latter photograph was, of course, taken in twilight; the path is much more clearly defined in this than with the smoke-shot, and there is the additional advantage that the paths of several shot can be shown on the same plate; also information is given with respect to the direction of the axis of the shot, and as to its oscillation. A. W.

224. *Internal Friction of Solids at Low Temperatures.* **C. E. Guye** and **V. Freedericksz.** (Comptes Rendus, 149. pp. 1066–1069, Dec. 6, 1909.)—By measuring the slackening of torsion oscillations Guye and Mintz (Archives des Sciences, 26. pp. 136 and 263, 1908) studied the internal friction of a number of metals, the results showing that the decrement increased very rapidly with rise of temperature. The object of the present investigation is to ascertain if the internal friction tends to disappear as the absolute zero of temperature is approached. It is found that for Ag, Al, and Fe the coefficient C_0 continues to diminish as the temperature is lowered; this is especially the case with Al, for which the value of C_0 is 274 times less at the temperature of liquid air than at 100° C. So far as can be ascertained, however, the value of C_0 does not tend to vanish at the absolute zero. For Mg and Au C_0 diminishes in value as the temperature is lowered to −80°, but increases again at −196°. For all the metals the moduli of elasticity increase as the temperature falls; with quartz, however, the reverse is the case. T. H. P.

225. *Viscosity of Gases.* **G. E. Allan.** (Phys. Zeitschr. 10. pp. 961–962, Dec. 1, 1909. Translation.)—Poynting's method of measurement is described, the apparatus used being similar to Zemplén's [see Abstract No. 1680 (1909)]. A horizontal brass disc is rotated about its axis by an electric motor, and is placed close below a smaller disc suspended by a wire attached to the centre. A guard ring surrounding the small disc obviates any edge effect, while a glass cover protects against air-currents. The viscosity is given by $2\pi I\theta d/\omega a^4 T$, where I is the moment of inertia, a the radius, and θ the deflection of the small disc, d the distance between the plates, ω the angular velocity of the large disc, and T the period of torsional vibration of the suspended system. A. D. R.

226. *Size of Pores in Porcelain and Osmotic Effects.* **S. L. Bigelow** and **F. E. Bartell.** (Amer. Chem. Soc., Journ. 31. pp. 1194–1199, Nov., 1909.)—The size of the pores in a network of capillaries may be deduced from the height to which water will rise, but more conveniently by determining the pressure required to displace the water by air. Measurements of this type were made with porcelain plates in conjunction with experiments made to determine whether these plates were capable of giving osmotic effects with cane-sugar solutions. The max. pore diameter for a distinct osmotic effect with porcelain was 0·37 micron; with porcelain clogged with barium sulphate, 0·59 micron; with porcelain clogged with sulphur, 0·49 micron. In order to harmonise this capillary theory of osmosis with the modern solution theory originally put forward by Lhermite, the view (suggested by Lhermite) is advocated that the process of solution itself is probably capillary in its nature. T. M. L.

227. *Pyrheliometer Observations by the Weather Bureau.* **H. H. Kimball.** (Mount Weather Observatory, Bull. 1. 2. pp. 83–93, and 4. pp. 207–231, 1908.)—The first of these papers gives an account of the comparison of the various pyrheliometers of the Ångström type used by the Weather Bureau with one another and with instruments of the Smithsonian Institution, and of the corrections applied to reduce all to a common standard. The Ångström instruments are found to read 11 per cent. lower than the standards of the Smithsonian Institution. In the second paper the results of observations of total solar radiation made with Ångström instruments on the roof of the Weather Bureau at Washington and at Mount Weather are given. Observations were made at Washington on 101 days between Dec. 22, 1905, and June 27, 1908, and on 40 days, commencing Sept. 21, 1907, at Mount Weather. The mean value of the solar constant deduced from the Washington observations is 2·015, the values ranging from 1·812 to 2·335 [see Abstract No. 1380 (1908)]. The corresponding figures for Mount Weather are, mean 2·027, maximum 2·255, minimum 1·854. R. G. K. L.

228. *Effect of Thunder on Raindrops.* **V. J. Laine.** (Phys. Zeitschr. 10. pp. 965–967, Dec. 1, 1909. Uleåborg, Finland, Oct., 1909.)—On Aug. 8, 1908, the author observed during a thunderstorm a well-defined primary rainbow together with a secondary bow. The bows were continuous from one horizon to the other, and whenever a peal of thunder was heard it was noticed that the colours of the primary, and especially of the secondary bow were strongly affected, and also that the colour boundaries and the edges of the bows were quite effaced. At the same time the different colours were very indistinct, and the whole rainbow oscillated very quickly. This happened every time it thundered. That the effect was due to the thunder and not to the lightning was seen from the fact that the time between the observation of a flash and the hearing of the thunder was from 20 to 5 sec., and during this time the phenomenon was not observed, but it began at almost the same instant that the thunder was first heard. At first the primary bow was very bright; the red then disappeared almost entirely, and the violet showed a great increase in intensity. Below the violet was a distinct dark space, especially marked in the case of the secondary bow, and below this was seen a small greenish-violet secondary bow. Then the oscillation occurred, and various other colour effects and peculiarities were noticed. An explanation of the observed effects is to be found in the variation of the size of the drops in the rainbow, according to the theory of the rainbow given by J. M. Pernter in his "Meteorologische Optik." From this it appears conclusive that the effect of the thunder is to increase the size of the raindrops. It is possible that the thunder-peals cause two or more drops to coalesce. **A. W.**

229. *Seismic Observations.* **A. Lo Surdo.** (Accad. Lincei, Atti, 18. pp. 439–444, Nov. 21, 1909. N. Cimento, 18. pp. 373–380, Nov.–Dec., 1909.)—The use of a liquid column for seismic observations is considered. With a tube of the form shown in Fig. 1 the horizontal component may be measured by noting the displacement of the meniscus in the arms, this being, for unit acceleration, equal to L/2g, where L is the length of the horizontal column. The ordinary equation of motion thus becomes $a'' + 2aa' + \frac{2ng}{L}a = \Omega$. The sensibility and period of the system are independent of the density of the liquid, and the sensibility is proportional to the length of the liquid column. By increasing the ratio of the sections of the tubes the period may be reduced without diminishing the sensibility. The vertical component of the seismic acceleration is measured by means of the apparatus shown in Fig. 2, the column of liquid in which is supported by the pressure of gas enclosed in C. The displacement is given by $B \sin 2\pi(t/\theta - \phi)$, and the acceleration by $- B4\pi^2/\theta^2 . \sin 2\pi(t/\theta - \phi)$, where B is the amplitude and θ the period of oscillation, so that the equation of motion of the liquid in this case becomes $a'' + 2aa' + \beta^2 a = \Omega_0 \sin 2\pi(t/\theta - \phi)$. It is thence deduced that $\Omega_0^2 = [4\pi^2/\theta^2 . 4a^2 + (\beta^2 - 4\pi^2/\theta^2)^2]A^2$, a being equal to $A \sin 2\pi(t/\theta - \psi)$. **W. H. Sᴇ.**

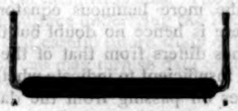


Fig. 1

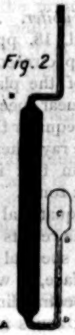


Fig. 2

230. *Variation of Latitude.* **J. Krassowski.** (Acad. Sci. Cracovie, Bull. 8. pp. 543–548, Oct., 1909.)—The author has applied Schuster's method to the analysis of the periods involved in the variation of latitude, investigations being made independently with Albrecht's x and y co-ordinates. No trace was found of an annual period, but there was an indication of a period of about 18 months. The Chandler period was very pronounced, being about 419·7 days for the x-co-ordinate and 410·6 days for the y-co-ordinate. The Kimura period of 488·0 days was found in both co-ordinates, but was somewhat less marked. A. D. R.

231. *Westward Motion of Seismic and Volcanic Centres.* **H. Wehner.** (Phys. Zeitschr. 10. pp. 962–965, Dec. 1, 1909.)—The author has investigated the apparent westward drift of seismo-volcanic centres of activity. By discussing the records for certain districts of destructive earthquakes and volcanic eruptions, he obtains 22 min. 41·845 sec. as the annual westward drift. This gives a complete revolution in 952 years—the length of the full period of the secular variation in terrestrial magnetism. Examples are given of this change in longitude of seismic centres, and the paper concludes with a discussion of the phenomenon in relation to the theory that the earth consists of a shell and a nucleus revolving with slightly different angular velocities.

A. D. R.

232. *Rotation of Jupiter.* **A. Bělopolsky [Bělopolískij].** (Acad. Sci. St. Pétersbourg, Bull. 18. pp. 874–875, Oct. 1, 1909.)—By observing the surface of Jupiter spectroscopically with the slit in a direction passing through the poles of the planet, the spectral lines observed are curved, indicating different linear speeds in different zones. In the region of the two dark zones about the equator the spectral lines exhibit slight bending, showing that the speeds of the rays there differ from the speeds in the neighbouring zones, especially from that in the more luminous equatorial zone lying between the two dark zones. There is hence no doubt but that the angular velocity of the dark equatorial zones differs from that of the other parts of Jupiter's surface. The results are insufficient to indicate whether there exists an interruption of the spectral lines on passing from the dark zones to the other parts of the surface, or whether the change is a gradual one. Another peculiarity of the spectral lines is that, contrary to expectation, they are narrower in the dark zones and broader in the more luminous parts of the disc. T. H. P.

233. *Observations of Mars made at Fabra Observatory* (*Barcelona*) *during the Opposition of* 1909. **J. C. Sola.** (Comptes Rendus, 149. pp. 1036–1038, Dec. 6, 1909.)—A double equatorial of 0·38 m. aperture was used, with a magnification of 450, and sometimes 550. The satellites Deimos and Phobos could be followed. The chief conclusions derived are: (1) The main topographical outlines remain constant (the author has observed Mars since 1890). The small details vary, doubtless owing to cloud, and, perhaps, vegetation. (2) The tonality is very changeable in the dark regions but practically invariable in the light regions. From this it is inferred that the clouds are of similar colour to the "lands" or that the "lands" are always covered with snow. In general, the details of the south hemisphere grew darker and more plentiful with the diminution of the southern snows, that is with increase of temperature. Syrtis Major, faint and scarcely perceptible in Aug., was dark and well defined in Oct. The canal Bathys was seen during this apparition, though invisible in 1907 with the same instrument. (3) Spotted and granulated structure is frequent in the dark regions. (4) A remarkable Martian feature is the series of peninsulas, all slanting in the same direction, which connect the white equatorial masses with the "islands" of the south hemisphere. In addition to the well-known ones, such as Atlantis and Hesperia, the author observed some new peninsulas, and convinced himself that these features are made up of groups of parallel wisps of various shades. (5) In the author's opinion, this opposition has finally disposed of the theory of a geometric network of canals. He himself did not see a single canal resembling a sharp geometric line during the whole season. Such canals as were seen, which were few in number, appeared as diffused shadings more or less linear. Some short dark bands were seen distinctly, but certain of them, such as Nectar and Bathys, were suspected to consist of a series of lakes. In general, the topographical contours on the planet (except a few regions including part of Syrtis Major and the northern boundaries of Sinus Sabæus) appeared more diffuse as the images improved. A. E.

234. *Gradual Shrinking of South Polar Cap of Mars during Opposition of* 1909. **R. Jarry-Desloges.** (Comptes Rendus, 149. pp. 1346–1349, Dec. 27, 1909.)—The South Polar Cap was observed from the beginning of June until the date of writing, when it was so small, and dull of hue, as to be barely perceptible. A series of 16 drawings shows the principal details observed, cracks, grey or dark regions, bright spots, &c., while the process of shrinking can be traced by help of a diagram constructed from micrometric measures by G. Fournier. The summer solstice for the south hemisphere occurred on Sept. 14. The lightest regions were situated, as a rule, approximately in the position of the so-called "islands," such as Novissima Thyle. The extra whiteness may be due either to more recent precipitation or to reflection of the solar rays from inclined planes. The general deduction from the observations is that the surface underlying the Polar Cap is of very varied relief, and it is suggested that careful future study of the phenomena accompanying the shrinking of the cap may furnish data concerning the contour of the ground and nature of the watersheds. A. E.

235. *Spectrum of Comet* 1908*c* (*Morehouse*). **H. Rosenberg.** (Astrophys. Journ. 30. pp. 267–288, Nov., 1909.)—Spectrograms of the comet 1908*c* were secured between Oct. 19 and Nov. 16, 1908, at Göttingen, with an ultra-violet prismatic camera. The plates used, "Agfa-Chromo," are very sensitive in the yellow-green. The spectrum presents an entirely different appearance from that of comet 1907*d*. The latter showed only two characteristic bands conspicuously at λ4738 and λ3880, and the remaining knots could be recognised only with difficulty, perhaps owing to the strong continuous spectrum. The new comet exhibited five very strong monochromatic images at wave-lengths 390, 409, 428, 456, 468 $\mu\mu$, and a few other much weaker but clearly recognisable knots. In order to obtain an independent determination of the wave-length of at least one of the knots, a small camera, having a double anastigmat lens of short focus and great light-power, was attached to the prismatic camera, and a transparent replica of a grating was placed in front of the lens. By this means a normal weakened image of the object is projected on the centre of the plate, with first-order spectra on either side. It is only necessary to expose on a bright star with strong lines, just before or after the comet exposure, and then the plate will furnish all the data necessary for reduction. With this small camera, the wave-lengths of the four brightest knots were obtained, viz., 3804, 3902, 4030, 4278 Å.U. On the basis of these values the plates of the prismatic camera, which had much more detail, were reduced. The wave-lengths of 9 bands are given. Two others, probably the 2nd and 3rd carbon bands, are faintly shown on the plates. The results indicate that the presence of carbon bands only can be asserted with certainty, but in view of Campbell's confirmatory results, three knots may be attributed to the 1st, 3rd, and 4th cyanogen bands. Of the 2nd cyanogen band no trace is shown. The author notes, however, that the edges of the images at λ3898 and λ4563 always appear sharp, and not diffuse like the edges of a band. The results agree in general with those of Campbell, Deslandres, Frost, and Hartmann, but not with Pluvinel's nor Baldet's. Pickering's identifications with hydrogen lines find no confirmation. The remarkable intensity of the photographic rays in comparison to the visual brightness of the comet made it appear desirable to compare the distribution of intensity in its spectrum with that of a star of known spectral type. For the purpose three plates were used on which the spectrum of *α* Lyræ had been photographed subsequently to that of the comet in order to derive dispersion formulæ. The distribution of brightness in the spectra of comet and star is exhibited in tables and curves. The marked increase in brightness of the comet compared to *α* Lyræ from λ450 to 350 *μμ* is clearly shown. The author suggests that the sunlight may be reflected by the minute particles of cometary material as in our atmosphere, and that the blue colour of the comet is comparable to the blue colour of diffusely reflected sky-light. This assumption is not contradicted by the fact that visual observations revealed no polarisation, for the brightness of reflected light of the comet is very small in comparison with that of the intrinsic light in the visual region, while the conditions are different for the photographic region. Upon this assumption, and regarding the portion of the comet producing the continuous spectrum as a cosmical dust-cloud, in which the diams. of the particles are of the order of wave-lengths, the author attempts to determine the ratio of the surface brightness of the continuous spectrum of the comet to that of *α* Lyræ and the sun. The surface brightness of the cometary particles, for albedo = 1, is found to be about 200,000 times less than that of a continuous surface. The result indicates that we are dealing with cometary matter so thinly scattered that there can be no talk of occulting and shadow-casting. An attempt is also made to deduce the comet's mass from the surface brightness. For albedo 1 it comes out as $5{\cdot}8 \times 10^{-19}$ of the earth's mass. For albedo 0·1 this value must be multiplied by 10. Measures of the comet's head gave its diam. as 5·8 times that of the earth. The falling off in brightness in the caudal images is much steeper for the cyanogen and carbon bands than for two unidentified lines at λ4035 and 4277 which were also observed in comet 1907*d*. A. E.

236. *The Absorption of Light in Space.* II. **J. C. Kapteyn.** (Astrophys. Journ. 30. pp. 284–317, Nov., 1909.)—The results of the author's previous paper [Abstract No. 625 (1909)], make it probable that there is an appreciable amount of selective absorption of light in space. In the present paper an attempt is made to obtain some quantitative determination of the loss. *Ceteris paribus* the phenomenon will manifest itself by rendering the more distant stars redder than the nearer ones. As a measure of average distance, the apparent magnitude and proper motion are taken, data being supplied by tables in Publications of the Gronigen Laboratory No. 8. As a measure of the degree of redness, the difference between the photographic and visual magnitudes is taken, data being furnished by Miss Maury and Miss Cannon's spectral classifications in Harvard observations. Northern stars only, 1488 in number, are used in the investigation. Photographic *minus* visual magnitude is a defective measure of redness, for it depends on the definition of photographic magnitude; and further, we cannot be sure that the degree of redness does not vary with the luminosity (*i.e.*, total light-power), even with stars placed in the same spectral class. Writing briefly, *Phot.* — *Vis.* for difference of magnitude as given in the Draper Catalogue, and Harvard Revision respectively, the author puts $\textit{Phot.} - \textit{Vis.} = a + bm + cM + d\Delta$; where m = apparent magnitude, M = absolute magnitude = apparent mag. at unit distance, Δ = distance, and a, b, c, d are constants to be determined by observation. b, c, d respectively denote the change in redness per unit of apparent magnitude, absolute magnitude, and distance. The bulk of the paper is occupied by the determination of these constants. One curious fact brought to light in the discussion is that the value of b changes with the spectrum. This would imply that, even for stars of the same spectral class, the ratio of the brightness in the violet to the brightness in the visual spectrum (or in the yellow) changes largely with the apparent magnitude. This need not necessarily hold for all spectral classes, however. The phenomenon can scarcely be a cosmical one, but must depend on peculiarities in the visual, or, more probably, the photographic, determination of magnitude. A sort of Purkinje phenomenon for photographic plates is well known. The value of b, however, plays a very unimportant part in the main results. But c is a cosmical constant, and its determination is of great importance. The value of c once found, the determination of d would be comparatively easy. Unfortunately, there is serious uncertainty in the value of c obtained, owing to the way in which the three unknowns b, c, d are connected. The summary of results states that: (1) A relatively good determination has been obtained for the quantity $d - 0{\cdot}25c$. Its adopted value is $0{\cdot}00525 \pm 0{\cdot}0010$ mag. (2) The value of c, if not zero, must be small, but cannot well be determined from the present data. The value found is $c = 0{\cdot}0058 \pm 0{\cdot}0112$ mag. A corresponding value of d, independent of any assumption as to c, is $d = 0{\cdot}0066 \pm 0{\cdot}0081$ mag. (3) There is no reason for assuming that the selective absorption is different for galactic and extra-galactic stars. (4) The values of *Phot.* — *Vis.*, freed from the influence of space-absorption, are tabulated. *Total Loss.*—In the above the *difference* between the losses for the visual and photographic rays is found. Rayleigh's law, that the scattering of light is proportional to the 4th power of the wave-length, gives the *ratio* of the losses. Hence if it can be assumed that all the loss of light is due to scattering, the total loss can be calculated for any wave-length. The author performs the calculation and finds that the total loss of light over a distance of 32·6 light-years (corresponding to parallax 0·1″), for the photographic rays, $= 0{\cdot}00867 \times$ total light $= 0{\cdot}00945$ magnitude. For the visual rays, the total loss $= 0{\cdot}00427 \times$ total light $= 0{\cdot}00465$ mag. [*Errata*, ibid. p. 398. Dec., 1909.] A. E.

REFERENCE.

237. ***Balloon and Kite Ascents on January* 31, 1909.** **V. V. Kuznecov.** (Acad. Sci. St. Pétersbourg, Bull. 16. pp. 1098–1102, Nov. 15, 1909.)—Tables and curves are given representing meteorological observations made by means of balloons and kites sent up from the Constantine Observatory on Jan. 18 (31), 1909. T. H. P.

LIGHT.

238. *Photographic Images which Change with the Point of View.* **E. Estanave.** (Comptes Rendus, 150. pp. 93–95, Jan. 10, 1910.)—A grating is placed in front of a photographic plate which is then exposed through three apertures in a line at right angles to those of the grating. Three different photographs may thus be taken on the one plate, and the positive can be viewed through apertures similarly situated to those through which the photographs were taken. [See also Abstract No. 589 (1908).] G. E. A.

239. *Preparation of Thin Films by Volatilisation in Vacuo.* **L. Houllevigue.** (Comptes Rendus, 149. pp. 1368–1369, Dec. 27, 1909.)—Thin metallic films can readily be obtained by electrically heating a wire of the metal in question in a high vacuum. To enable a uniform deposit to be obtained the vessel is rotated during the operation. Very good deposits of Pt, Au, Ag, Fe, Cu, Cd, Zn, Sn can be formed in this way, but their reflecting power is not equal to the mirrors obtained with the kathode streams. E. C. C. B.

240. *Resolving Power of Objectives.* **P. G. Nutting.** (Bureau of Standards, Bull. 6. pp. 121–124, Oct., 1909.)—The resolving power of objectives may be determined experimentally with simple but sensitive apparatus. Denoting by ϕ the least angular separation between the objects to be clearly separated in the image, $\phi = a\lambda/r$, where a is a constant and r the radius of the lens. It is found that, photographing one half of an uncemented half-tone screen, the constant a varies from 0·50 for an image showing no detail, to 0·90 for an image just free from defects. The theoretical value of a, 0·61, corresponds to a very diffuse but recognisable image. Further conclusions are: Every lens fulfils its computed resolving power, but this is masked by residual aberration except in the case of the telescope and other objectives that are carefully freed from third-order axial aberrations. The camera objectives examined show best resolution at about $f/10$. In any lens system to be used at full power, no lens should have a smaller aperture ratio than the objective. G. E. A.

241. *Polychroism of Artificially Coloured Crystals.* **P. Gaubert.** (Comptes Rendus, 149. pp. 1004–1006, Nov. 29, 1909.)—With artificially coloured crystals which exhibit polychroism, the unequal absorption of light along different directions in the crystals occurs in two ways, corresponding with the two different conditions of the colouring matter in the crystals: (1) as a solid solution; (2) as crystalline particles, the two substances existing in regular orientation. According to Lehmann, a relation apparently exists between the intensity of the polychroism and the birefraction of the coloured crystal, but the author's observations indicate that such relation can only exist when the colouring matter exists in the form (1). Thus, crystals of lead and barium nitrates coloured with methylene blue—as crystalline particles—exhibit intense polychroism, although their birefraction is very feeble and sometimes almost zero. Further experiments confirm these views. T. H. P.

242. *Magnetic Dichroism of Liquids containing Spathic Iron Ore.* **G. Meslin.** (Comptes Rendus, 149. pp. 855–857, Nov. 15, 1909.)—A suspension of crystals of spathic iron ore exhibits slight negative magnetic dichroism, which is increased considerably in intensity by a feeble magnetic field transverse to the ray. Several methods are described for rendering this phenomenon visible. [See next Abstract.] T. H. P.

243. *Magnetic Dichroism.* **G. Meslin.** (Comptes Rendus, 149. pp. 986–988, Nov. 29, 1909.)—The phenomenon [see preceding Abstract] might be attributed to the orientation of the anisotropic particles in the liquid under the action of the magnetic field; but experiments made up to the present have failed to detect the presence of this orientation under the same conditions as those under which magnetic dichroism appears. The behaviour of siderose, which is exceptional in giving the expected orientation, is described. G. E. A.

244. *Change of Hue of Spectrum Colours by Dilution with White Light.* **W. de W. Abney.** (Roy. Soc., Proc. Ser. A. 83. pp. 120–127, Dec. 10, 1909.) —That a change takes place in the hue of the spectrum-colours when white is added to them has been previously noticed. The present paper gives a quantitative investigation of the phenomenon. By a modified apparatus for the measurement of colour [see Abstract No. 72 (1906)] the author found that the hue of Scale No. 48·7 (λ5772) was not altered by the addition of white light. It is further stated that at this point of the spectrum the proportions of red and green are exactly those existing in white light, also that Scale No. 48·7 is the place where the red and green curves of equal stimulation of the three sensations cut one another. But for colours either at the red side or the blue side of Scale No. 48·7 the addition of white light makes the hue yellower, and the change of hue is greater, the greater the amount of white light added. The original paper has three tables of observations and a figure depicting the change of hue by curves. E. H. B.

245. *Series Systems in the Spectra of Zinc, Cadmium, and Mercury.* **F. Paschen.** (Ann. d. Physik, 30. 4. pp. 746–754, Nov. 30, 1909.)—In the spectrum of Mg there are now known three different series systems: (1) two subordinate and one principal series of triplets; (2) three pairs of equal frequency-difference, and (3) the Rydberg series of isolated simple lines and the Fowler series of simple lines, both of which have the same limit. Three similar series should also exist in other spectra, and Saunders noted in Zn and Cd two series of simple lines corresponding to the series of simple lines of Mg. The author has calculated the Saunders series again, using as the basis lines the very strong infra-red lines which hitherto have not been made use of. The values calculated agree exceeding well with those observed. The same has also been done for Hg. Some further interesting points arise in connection with the structure of the lines and their magnetic resolution. The author points out that the structure of all the lines of these new series should be simple, and there should be no satellites. As far as has been observed this is the case. In the cases of Cd and Hg only the lines of the new series are free from satellites. Again, the Hg lines 4916 and 4108 give normal Zeeman triplets, and it is therefore probable that this is a characteristic of all the lines of the new series. Now, the combination series in the case of Hg (giving the first triplet subordinate series) shows an anomalous Zeeman-effect. It would follow that the anomalies in the Zeeman-effect are not dependent on the series distribution of the lines, but upon the same influences which give rise to doublets and triplets, &c. **T. Royds.** (Ibid.

80. 5. p. 1024, Dec. 14, 1909.)—Royds gives the results of a measurement of the Zeeman resolution of the lines referred to in Paschen's paper, Cd 6438, Zn 6363, Mg 5529 and 4703, Hg 4916 and 4108. The values of e/m were 1·76, 1·77, 1·72, 1·67, 1·78, $1{\cdot}62\times10^7$ respectively. E. C. C. B.

246. *The Yellow, Orange, and Red Regions of the High-temperature Flame Spectrum of Calcium.* **G. A. Hemsalech and C. de Watteville.** (Comptes Rendus, 149. pp. 1369–1372, Dec. 27, 1909.)—The spectrum of Ca as obtained in the oxy-acetylene flame shows that it is very rich in the arc lines of this element. A comparison is made with the spectrum obtained by King in his electric oven, and the distribution of intensities is found to be the same in both cases. This is interesting, owing to the fact that the temperature is nearly the same in the two methods (2800°). One line ($\lambda = 6708$) was given by King as a low-temperature line, but the authors have not found it in any of the low-temperature flames, and they suggest that it is due to the presence of Li as an impurity. E. C. C. B.

247. *Complex Structure of the Spectrum Lines of Mercury.* **H. Nagaoka.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 9. pp. 140–144, Oct., 1909.)—Dealing with the structure of the principal lines of Hg, the author points out that there is a certain symmetry in the arrangement of the satellites somewhat resembling the Zeeman-effect. If the electronic motions which are radiating light-energy are subject to constraint from internal or external agency, the period will be affected, minute changes being produced affecting the waves emitted. It is possible that the symmetry of the satellites may be attributable to the existence of atomic magnetic fields. E. C. C. B.

248. *Degree of Completeness of the Circular Polarisation of Magnetically Divided Lines.* **P. Zeeman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 345–356, Nov. 25, 1909. Phys. Zeitschr. 11. pp. 1–7, Jan. 1, 1910.)—A careful determination of the amount of ordinary light emitted along with the polarised components of magnetically resolved spectrum lines. An echelon grating was employed, and the lines examined were those of Hg, Na, and Tl. In these cases the displaced components emitted parallel to the lines of force are completely circularly polarised, and the amount of ordinary light which might be emitted with the circularly polarised light in the case of certain lines is less than 1 per cent. of the total intensity of the line. E. C. C. B.

249. *Phosphorescence of Certain Inorganic Salts.* **J. A. Wilkinson.** (Journ. Phys. Chem. 13. pp. 691–728, Dec., 1909.)—The author's investigations show that there is a definite close relation between chemical action and phosphorescence. A number of salts prepared by electrolysis or by the direct union of the metal with the acid radical emit light during their formation. With sodium and potassium the light emitted during slow union with the acid radical is different from that given out during rapid union, the colour of the phosphorescence and thermo-phosphorescence being the same as that of the light emitted during the slow union. In nearly every case the phosphorescent light is of the same colour as the light given out during chemical combination. Cadmium and lead sulphates are decomposed on exposure to kathode rays, residues of cadmium oxide and finely-divided lead respectively being obtained. Electrolysis of some of the fused alkali halogen salts by means of an alternating current is not accompanied by any characteristic glow such as is observed when these salts are heated on a Pt-wire in the flame. The fluorescence of aluminium oxide under the influence of kathode rays is found to be due to the presence of sodium in the form either of peroxide or of aluminate. T. H. P.

280. *Experimental Decision between the Æther-wave and Light-quantity Hypotheses. I. Röntgen Rays.* **J. Stark.** (Phys. Zeitschr. 10. pp. 902–918, Nov. 22, 1909.)—The general problem is first considered from a theoretical standpoint, then the special problem of the generation of Röntgen rays by a bundle of kathode rays. It is concluded that the emission of Röntgen rays by a carbon antikathode is unsymmetrical in relation to the plane normal to the incident kathode rays, both with respect to their intensity and also to their absorption coefficient. If one accepts this want of symmetry in the emission of Röntgen rays as experimentally certain, then various conclusions can be drawn from this phenomenon. If it is assumed that the Röntgen rays are electromagnetic rays, which are polarisable and are propagated with the velocity of light, then through two facts the distinction between the æther-wave and light-quantity hypotheses is demonstrated. The first fact is that when a bundle of kathode rays is compelled by collision to alter its mechanical momentum, Röntgen rays are not generated with equal intensity and equal absorbability in all directions, but on the rear side of the normal plane the rays possess greater intensity and smaller absorbability than in the opposite direction. The second fact is that Röntgen rays at great distances from their centre of emission generate kathode rays possessing energy of the same order of magnitude as that of the primary kathode electrons. These facts can scarcely be explained by the æther-wave hypothesis, but may be, perhaps, with the help of the light-quantity hypothesis, according to which the electromagnetic radiation energy does not spread out uniformly in all directions, but remains concentrated in a finite volume, the centre of gravity of which moves with the velocity of light. The inverse of the phenomenon of the emission of Röntgen rays by kathode rays is the emission of secondary kathode rays by the absorption of Röntgen rays. If Röntgen rays are absorbed by a thin plate of a substance, we must then assume that more secondary kathode rays will proceed from the back of the normal plane than from its front side, and, further, the latter rays must have a smaller average velocity than the former rays. The β-rays of the radio-elements are quick kathode rays, and the γ-rays probably Röntgen rays of very high frequency, so by analogy the same arguments may be applied to these. A. E. G.

281. *Transmission of β-Rays through Matter.* **H. W. Schmidt.** (Phys. Zeitschr. 10. pp. 929–948, Dec. 1, 1909.)—This paper is divided into three parts, dealing with (*a*) distribution of the rays and the loss of velocity, (*b*) dependence of the radiation constants on the atomic weight, and (*c*) the absorption in gases. The conclusions arrived at as a result of the work are as follows: The β-rays experience in their passage through matter a small loss of velocity; this loss is so much the greater the lower the atomic weight of the substance through which the rays pass, and the more the rays are bent out of their original direction. The curves for the transmitted radiation are in a large measure dependent upon the conditions of research. If in the bundle of rays there are some which have been previously influenced by other material, then the penetrating power of this bundle will be less than that of one which has not been so influenced. When a bundle of rays consists of parallel rays, its penetrating power is greater at first than that of a bundle in which the rays are more evenly distributed; this effect, however, is only to be noticed with substances of low atomic weight, for with those of higher atomic weight the strong diffuse scattering is such as to quickly compensate for any irregularity in the distribution of the rays. When the thickness of the substance is not too small the transmitted radiation can be expressed by the formula $I_{(xD)} = I_0 e^{-(\mu/D)_0 xD - p(xD)^2}$. The experimentally determined radiation constants, μ/D and p, depend upon the atomic weight of the substance. This is explained by assuming that the β-rays in their passage through matter are absorbed and diffusely scattered. Hydrogen shows relatively to air under the influence of the β-rays a very high specific ionisation power. This is explained by the dependence of the absorption on the atomic weight, the specific absorption being inversely proportional to the cube root of the atomic weight, and on the further assumption that in air and hydrogen ionisation and absorption are proportional to one another. Bromine vapour shows a smaller specific ionisation than air, still it is not so small but that it may be accounted for on the above theory. A. E. G.

252. *Production of Helium by Radium.* **E. Rutherford** and **B. B. Boltwood.** (Manchester Lit. and Phil. Soc., Mem. 54. 1. pp. 1–2, 1909–1910.)—Rutherford and Geiger have calculated that 1 gm. of Ra in equilibrium should produce 155 mm.³ of helium per year. The experiments of Dewar [see Abstract No. 1808 (1908)] indicate that helium is produced at a constant rate equivalent to 135 mm.³ per gm. per year. By using 200 mgm. of a barium-radium salt freed from polonium and RaD it is now found that the rate of production of helium corresponds to 168 mm.³ per gm. per year. By experience gained in these preliminary experiments it is hoped to be able to determine the value of this constant with considerable precision. It is also proved that helium is produced by polonium. A. E. G.

253. *Krypton and Xenon in the Gases of Thermal Springs.* **C. Moureu** and **A. Lepape.** (Comptes Rendus, 149. pp. 1171–1174, Dec. 13, 1909.)—Besides argon, helium, and neon, which have previously been found in the gases from numerous springs, the authors have found krypton and xenon in 26 sources examined. The lines identified and their comparative intensity are stated. L. H. W.

REFERENCES.

254. *Method for Constructing the Natural Scale of Pure Colour.* **P. G. Nutting.** (Bureau of Standards, Bull. 6. pp. 89–93, Oct., 1909.)—The power of the eye to detect small colour-changes varies, as is known, very far from uniformly throughout the spectrum. The author makes use of Steindler's data on the difference limen [see Abstract No. 1392 (1906)] and shows how a natural scale can be constructed. E. C. C. B.

255. *Normal Wave-lengths in the Iron Spectrum.* **P. Eversheim.** (Ann. d. Physik, 30. 4. pp. 815–839, Nov. 30, 1909.)—A measurement of about 58 lines between the limits λ=6945 and λ=4282 with a probable error averaging less than 0·001 Å.U. The method employed was in the main that of Perot and Fabry as modified by Fabry and Buisson [see Abstracts Nos. 242 and 775 (1908)]. E. C. C. B.

HEAT.

256. *Boiling-point of Sulphur corrected by means of New Observations on the Absolute Expansion of Mercury.* **H. L. Callendar** and **H. Moss.** (Roy. Soc., Proc. Ser. A. 83. pp. 106–108, Dec. 10, 1909.)—The value 443·58° obtained by Eumorfopoulos [see Abstracts Nos. 83, 84 (1909)] for the boiling-point of sulphur was arrived at by assuming Regnault's results as re-calculated by Broch for the absolute expansion of mercury. The authors have now measured this expansion up to a temperature of 300°, and their results, which are shortly to be published in full, indicate that Eumorfopoulos' value for the boiling-point of sulphur must be increased by 0·97°, giving 444·55°. This value is practically identical with the value previously assumed, namely, 444·53°, on the scale of the constant-pressure air thermometer. T. H. P.

257. *Conditions Necessary for the Incandescence of Platinum in the Interior of the Bunsen Burner.* **J. Meunier.** (Comptes Rendus, 149. pp. 924–926, Nov. 22, 1909.)—Continuing his previous experiments [Abstract No. 660 (1909)], the author finds that a Pt-wire placed in a lighted Bunsen burner remains incandescent even when pushed down into the tube of the burner. This property disappears if the wire is cleaned by means of hydrochloric acid, but returns when the wire is rubbed between the fingers if the latter have been washed only with soap and ordinary water, and not with acidulated distilled water. The phenomenon is due to the presence on the wire of traces of saline substances, and the duration of the incandescence of the wire is related to the weight—starting from a certain limit—of the solid present. Hence it is not the Pt which causes the incandescence and the converging combustion, but the saline substances carried by the metal. T. H. P.

258. *Drying of Air for Liquefaction.* **G. Claude.** (Comptes Rendus, 149. pp. 915–917, Nov. 22, 1909.)—For the drying of air to be liquefied by the author's system it is not sufficient to freeze out the moisture at 0°, for the small proportion of water-vapour with the pressure 4·5 mm. left in the air would cause serious obstruction in the apparatus on further cooling. The author therefore adds to the compressed air, before cooling, a quantity of alcohol equal to one-half that of the water present, that is 0·5 gm. per m.³ of air; during the cooling the vaporised alcohol, together with the whole of the water-vapour, undergoes condensation. By this means the apparatus can be worked continuously for 150 hours without any obstruction occurring. About three-fourths of the alcohol employed is recoverable in a form in which it can be again used. The amount of cold neutralised by the liquefaction of the alcohol and water-vapour is small. T. H. P.

259. *Thermal Conductivity of Air and other Gases.* **G. W. Todd.** (Roy. Soc., Proc. Ser. A. 83. pp. 19–39, Nov. 3, 1909.)—An account is given of the determination of the thermal conductivity of air by a new method suggested by Poynting in which the conductivity is measured at ordinary pressures, there being no need to take precautions against convection currents by the reduction of the pressure as is necessary in the other methods. If a layer of air is enclosed between two parallel good conducting plates maintained at different temperatures, the colder plate will receive heat by radiation and conduction through the air. There is no reason to suppose that convection can take place if the plates are horizontal, the distance between them small compared with the linear dimensions, and the upper one at the higher temperature. Communication with the surrounding air is cut off by an insulating ring. One of the plates is movable up and down, its surface being always parallel to the surface of the other plate. Then, assuming that no complications are introduced by the ring, the quantity of heat passing in each second from the upper plate to the lower at a distance x from it is $Q = K/x + R$, where R is the radiation between the plates and K is constant, provided the temperature of each plate is kept constant. If x is varied and the corresponding values of Q are plotted on a curve, a rectangular hyperbola is obtained, the horizontal assymptote giving the value R of the radiation. The conductivity of the air is then obtained, the dimensions and temperatures of the plates being known, from $K = x(Q - R)$. Correction has to be made for the radiation effect of the insulating ring which consisted of a cylinder of paper. The experiments carried out and the apparatus used are fully described in the paper. The value found in the first set of experiments for the thermal conductivity of air at ordinary pressures and in the neighbourhood of 55° C. was $k = 0{\cdot}0000564$. Another series of experiments with improved apparatus gave for air and for some other gases by comparison with air the values stated in the following table :—

Gas.	k_{55}.	Gas.	k_{55}.
Air	0·0000571	N_2	0·0000569
CO_2	0·0000411	NO	0·0000589
O_2	0·0000593	NO_2	0·0000888

J. J. S.

260. *Vapour Tension at Low Temperatures.* **L. Rolla.** (Accad. Lincei, Atti, 18. pp. 365–378, Nov. 7, 1909.)—It is deduced from the Clausius-Clapeyron equation for the heat of vaporisation, $\lambda = T . dp/dT . (v - v_0)$, and from the equation $p(v - v_0) = RT(1 - p/\pi)$, that $\lambda = (\lambda_0 + 3{\cdot}5T - \epsilon T^2)(1 - p/\pi)$, whence $\log_{10} p = -(\lambda_0/4{\cdot}571)T + 1{\cdot}75 \log T - \epsilon T/4{\cdot}571 + C$, where p is the vapour tension in atmos. at the absolute temperature T, and λ_0, ϵ, and C are constants. It is further deduced that at the absolute zero the molecular heat of a vapour at constant pressure exceeds that of the condensed substance by 3·5 gm.-cals. Based on these considerations, an apparatus has been devised by Nernst for the measurement of vapour pressures at low temperatures, and those of ice, naphthalene, brombenzene, and iodobenzene have been determined by the author for temperatures down to −48·5°, the results obtained being in close agreement with those found by other investigators. W. H. St.

261. *Adiabatic Expansion of Saturated Liquids.* **E. Mathias.** (Journ. de Physique, 8. pp. 888–908, Dec., 1909.)—This paper is a continuation of, and requires to be read in connection with, a former one [see Abstract No. 947 (1908)]. The author considers a mixture of a liquid and its saturated vapour of composition, x. The composition changes by conversion of liquid into vapour, or *vice versa.* The notation is explained in the former paper, in which the author proposed to establish the formulæ $d\theta/dv = -1/c_m$, and $dx/dv = mx/(u' - u)\, c_x$ as sufficient to solve the problems of this paper. Following his own experimental determination for the case of sulphurous anhydride, he gives a graphic representation of the behaviour of that substance for pairs of different values of x from $x = 0{\cdot}1$ to $x = 0{\cdot}9$, showing two points of "inversion" as defined in the former paper, of the specific heat m', that is points where at constant volume m' has different values for the two values of x respectively. In the present paper he refers to his own treatise of 1890 and a treatise "On the

Study of the Calorimetry of Saturated Liquids," by himself (Ann. de Fac. des Sciences de Toulouse, 1st series, t. X, 1896) as showing that certain bodies may have a double point of inversion and others no such point. A double point differs, he says, little from two distinct points. The present paper occupies itself with the discussion of points of inversion. It is copiously illustrated with figures, which are essential to the proper understanding of it. He discusses also the variation of the composition. If x, representing the quantity of vapour, be very nearly zero, there is practically no point of inversion. If there is zero liquid illustrated in Fig. 5 in the original, the vapour follows the law of a perfect gas, and he shows that γ, the ratio of the two specific heats $= 1{\cdot}417$. **S. H. B.**

262. *Platinum Resistance Thermometry.* **C. W. Waidner and G. K. Burgess.** (Bureau of Standards, Bull. 6. pp. 149–230, Nov., 1909.)—An investigation undertaken to determine the advantages and limitations of platinum resistance thermometers at high temperatures, especially with reference to reproducibility of scale, method of calibration, formulæ best expressing the relation between resistance and temperature, effect of impurities in the wire, and the most satisfactory methods of construction and use. These points are fully dealt with in the experimental investigation, and the following are among the conclusions arrived at: Temperatures defined by the resistance thermometer of pure Pt calibrated by Callendar's formulæ at 0°, 100°, and 444·70°, agree with temperatures on the generally accepted gas scale in the range 0° to 1100° C. to within the degree of reproducibility of the latter. Thermometers of impure Pt calibrated in the same way do not define the same temperature scale as that of pure Pt, but if such thermometers are calibrated at a fourth temperature, such as the silver freezing-point, and if for the coefficient δ is written $a + bt$, then the scale so defined by these thermometers is brought into close agreement with that of the thermometer of pure Pt. The Dickson formula $(\mathrm{R} + a)^2 = p(t + b)$ is not applicable to either Pt or Pd thermometers at high temperatures. The Pd thermometer gives temperatures agreeing to 1° with the scale of the Pt thermometer up to 600°; it requires a fourth-degree equation to express its resistance-temperature relation from 0° to 1100°. Thermo-couples of Pt, 90Pt-10Rh, and Pt, 90Pt-10Ir, calibrated at three temperatures in terms of the formula $\mathrm{E} = a + bt + ct^2$, define a temperature scale in the interval 200° to 1100°, which is in agreement with the platinum resistance scale at intermediate temperatures to within 0·8°. The gradual change of Pt thermometers when used at high temperatures necessitates frequent recalibration; the changes in the thermometer constants are greatly reduced though not eliminated by annealing the thermometers for at least several hours at a temperature higher than that at which they are subsequently to be used. The changes are least for pure Pt wires of large diam. suspended free from strain. For impure Pt wire the effect of high temperatures is to decrease R_0 and to increase the fundamental coefficient $\mathrm{C}[= (\mathrm{R}_{100} - \mathrm{R}_0)/100\mathrm{R}_0]$. The freezing-points of pure metals are the most satisfactory calibration temperatures, but, unless a very slow rate of heating is used, melting-points are less steady, and apparently slightly higher, than freezing-points. The temperature of the Ag-Cu eutectic is an entirely satisfactory fixed point at 779·2°, also the copper-cuprous oxide at 1063·2°. The sulphur boiling-point is a most satisfactory fixed point, being reproducible to a few hundredths of a degree, when proper precautions are used. The appendix contains 27 tables of results and also a very extensive bibliography. **G. E. A.**

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

263. *Potential Gradient at varying Altitudes.* **M. Dieckmann.** (Deutsch. Phys. Gesell., Verh. 11. 22. pp. 699–703, Nov. 30, 1909. Paper read before the 81. Versamml. Deutsch. Naturforscher u. Ärzte, Salzburg, Sept. 22, 1909.) —Two methods elaborated at the Technical School, Munich, for determining the variation of potential gradient with altitude are described. A captive balloon (17 $m.^3$, lift force 10 kg., cost about 800 marks) is used for obtaining soundings up to 500 m. A polonium electrode is sent up with the balloon; if in good condition the action of the electrode is found to be so effective that discharge along the wire, &c., may be neglected. Insulation is provided by insulating the drum on which the wire is wound. Connection to the electrometer is made by a sliding contact. For altitudes up to 15 m. collectors attached to specially insulated bamboo poles 4, 8, and 12 m. high, placed 30 m. apart, are used. As electrometers, Braun voltmeters are used, and also a balance in which the electrostatic attraction of two plates is compensated by the electrodynamic attraction of two coils. R. G. K. L.

DISCHARGE AND OSCILLATIONS.

264. *Photo-electric Effect.* **E. Bloch.** (Comptes Rendus, 149. pp. 1110–1112, Dec. 13, 1909.)—An investigation was made of the photoelectric powers of certain metals for ultra-violet radiations of definite wave-length. The source of light was a quartz mercury lamp, the radiations being analysed by a spectrograph with quartz prisms. The rays employed were those of wave-length 313, 280, 265, 254 $\mu\mu$; the metals being Zn, Al, and Cu, which were placed in air at ordinary temperature and pressure and in a field of the order of 100 volts per cm. (1) For a given metal and ray the effect depends on the degree of polish of the surface, and the best effect is not necessarily obtained with the best polish. Immediately after polishing there may be a progressive fatigue, or a spontaneous increase of the effect followed ultimately by a fatigue. (2) The effect of different rays on the same specimen of a given metal is strongly selective. Thus the ray 254 always gave effects superior to those of the ray 313, although more intense. (3) The variations of the effect with time or with the degree of polish of a given metal are extremely different for the different rays. In a group of rays the ray which is most active on a given metal is not always the same. (4) On comparing two different metals for the same rays the ratios observed for the one and for the other are not at all equal, nor even comprised between the same limits. The selective properties of the diverse radiations are shown. The order of two metals in the list of photoelectric powers may be inverted on passing from one wave-length to another. Thus there may be two specimens of Al and of Zn such that at a given moment the first may be more photoelectric than the second for the ray 313, and less than the second for the ray 280. The classification of the metals in order of photoelectric power is susceptible of great modification on passing from one wave-length to another, and has only meaning for a definite ray. J. J. S.

265. *Spectral Analytical Investigation of the Glow Discharge from Point Electrodes.* **H. v. Dechend.** (Ann. d. Physik, 30. 4. pp. 719–745, Nov. 30, 1909. Extract from Inaug.-Dissertation, Freiburg, 1909.)—Point electrodes of Pt or Al were used in tubes varying from 1·5 to cm. in diam., and the distance between them varied from 0·4 to 4 cm. The discharge was obtained with an accumulator battery of 5000 volts, or an influence machine. In the cases of oxygen, chlorine, and nitrogen very little difference was observed from the results with ordinary vacuum tubes. With hydrogen, in addition to the bright points on the electrodes, which showed the primary and secondary line spectra, an electrical wind-discharge stretched out from the kathode independently of the position of the anode. This stream was deviated by a magnet, and found to consist of negative ions. The spectrum shows a series of nebulous lines, the wave-lengths of which are given. HCl, CO, CO_2, CH_4 were also examined; the first and last were decomposed, showing hydrogen and chlorine and the Swan spectrum respectively. CO and CO_2 behave rather differently from ordinary vacuum tubes. In CO all the principal bands of the carbon monoxide spectrum are seen, while only $\lambda = 4123$ appears in CO_2. In CO there appear also some of the Swan bands, the principal bands of the third positive group of Deslandres, and also a series of new lines. E. C. C. B.

266. *Effect of Capacity of Electrodes on the Discharge.* **E. Caudrelier.** (Comptes Rendus, 149. pp. 919–922, Nov. 22, and pp. 1117–1120, Dec. 13, 1909.)—The electrodes are supposed to act like a condenser with holes pierced in it. Some electricity accumulates on them and some passes through, producing a current. He then shows that the theory suffices to explain all the experimental results obtained by Klingelfuss. The fact that the p.d. between the electrodes, and consequently the mean value of the secondary current, varies inversely as the capacity in the primary, follows directly from the equations of an ionised medium. This theory also explains why the distances between the striations in short sparks remains sensibly constant when the primary capacity is altered, and why these distances in long sparks vary very appreciably with the primary capacity. A. R.

267. *Velocity of Rotation of the Electric Discharge in Gases in a Radial Magnetic Field.* **J. A. Vollgraff.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 428–437, Dec. 28, 1909.)—It is shown that the relation, velocity of rotation $U = k_1 k_2 HX$ (where k_1, k_2 are the velocities which unit electric intensity acting on the gas gives to a positive and a negative ion respectively, H is the magnetic, and X the electric intensity at the place of discharge), may be deduced mathematically in a different way from that employed by Wilson and Martyn [Abstract No. 1672 (1907)]. It is possible that the path of the discharge has an arbitrary small inclination β, and that electric charges exist at the front and back of the discharge, and since whatever the inclination, the right value for U is always obtained, it is probable that the inclination is determined by local conditions of the metal, and that the electric intensity Y, and the charges to which it is due, adjust themselves to it according to the relation $\tan \beta = (k_2 - k_1)H - Y/X$. W. H. Sr.

268. *Electrical Discharges on Photographic Plates.* **A. W. Porter.** (Röntgen Soc., Journ. 6. pp. 14–18; Discussion, pp. 18–22, Jan., 1910.)—A photographic plate is taken and a plate of copper placed at the back of it. The Cu plate forms one of the electrodes attached to a terminal of an induction coil, and the other terminal is connected with a wire on the opposite (sensitive) side of the plate, touching it near the centre. When a spark is made to pass from the coil, a discharge of electricity takes place over the surface of the plate, and the plate is then developed in the usual way. The effects obtained depend upon the conditions of working. The author has extended the observations made by earlier observers by investigating the case when a partial vacuum is formed round the plate. Observations were also made when the plate was surrounded by various gases, each gas giving a figure characteristic of itself. The effects obtained when a blast of air was sent across the plate were observed, and also those which occur when the plate is placed in a magnetic field. Reproductions of the photographs obtained in the various experiments are given. The phenomena are complicated and no simple explanation has yet been obtained. J. J. S.

269. *Coupled Circuits in which the Secondary has Distributed Inductance and Capacity.* **L. Cohen.** (Bureau of Standards, Bull. 6. pp. 247–258, Nov., 1909.)—In a previous paper the problem of coupled circuits having localised inductance and capacity was discussed [see Abstract No. 1625 (1909)]. In a radiotelegraphic system, however, the antenna which forms part of the secondary circuit has distributed inductance and capacity. Such a system will oscillate with an infinite number of frequencies. The author discusses how this distributed capacity affects the two fundamental frequencies, the formulæ for which he has previously given. In order to simplify the problem, the resistance is neglected entirely. The complete analytical solution is obtained, and a neat graphical method is given for determining all the frequencies. The first two roots represent the two fundamental frequencies, and the other roots represent the harmonics. A numerical example is worked out. The values of the fundamental frequencies found by the two methods differ by 18 and 18 per cent. respectively. Increasing the ratio of the localised inductance in the secondary to the total inductance brings the values of the frequencies as computed by the two methods more closely together. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

270. *Variation of Conductivity of Glass with the Temperature.* **L. Dunoyer.** (Comptes Rendus, 149. pp. 1120–1122, Dec. 13, 1909. Ind. Élect. 19. pp. 41–42, Jan. 25, 1910.)—The author has investigated, by means of a Curie electrometer, the conductivity of glass under a field not exceeding 0·5 volt per cm. After charging, the diminution in voltage is represented by a straight line between the time and the log. of the deviation. It follows from this that the current is proportional to the p.d. producing it, that is, Ohm's law holds, and the glass must be regarded as having a definite conductivity. The results suggest that the conditions under which dielectrics are examined would, from certain points of view, be better defined if very weak fields were always employed. Further experiments indicate that diminution of the conductivity with increase of the duration of the charge occurs with weak as well as with more intense fields (compare Curie, Ann. Chim. Phys. 6. 18. p. 244, 1889), though more slowly than in the latter case. The curve representing the variation with temperature of the coefficient k, which is proportional to the conductivity, shows that this conductivity remains extremely slight up to about 150° ; an apparent diminution occurring between 16° and 150° is due

to the improved drying of the glass. Between 160° and 220° the conductivity increases extremely rapidly, insulation with glass becoming then impossible.
T. H. P.

271. *Conductivity of Certain Insulators at High Temperatures.* **M. v. Pirani and W. v. Siemens.** (Zeitschr. Elektrochem. 15. pp. 969–978, Dec. 15, 1909.)—The authors discuss a number of sources of error in the measurement of the conductivity of insulators at temperatures up to 1600°. The conductivities of Marquard material, porcelain, and quartz have been measured at various temperatures—up to 1600°—the results being in accord with Rasch and Hinrichsen's law, $\log K = -N/T + C$ [compare Abstract No. 672 (1908)].
T. H. P.

272. *Radiographs obtained with Momentary Exposures.* **F. Dessauer.** (Phys. Zeitschr. 10. pp. 859–860, Nov. 10, 1909. Paper read before the 81. Naturforscherversamml., Salzburg.)—To obtain a radiograph which shall register the shape of the organs at a definite instant it is necessary, the author considers, to have an exposure of not longer duration than about 1/100 sec. Such an exposure might be effected by means of an instantaneous shutter in a manner similar to ordinary camera exposures, an extraordinarily powerful beam being, of course, employed therewith. The author has, however, proceeded in another way. He employs a spark coil of very large magnetic dimensions, and uses a single spark from this, passed through a tube of medium hardness. But the break has to be extremely sudden. It was found that the best method of effecting instantaneous rupture was to employ a fine calibrated metal thread or wire surrounded with a coating of hygroscopic material (such as a mixture of plaster and clay, &c.), the complete "fuse" being included in the primary circuit of the coil. On switching on the current, the steam generated by the heated wire causes the "fuse" to explode, a most rapid break in the circuit being thereby effected. The discharge obtained has the form of a broad band of flame, and leaps across a gap of 40–50 cm. The secondary current obtained is over 200 milliamps. Radiographs of the beating heart, taken by this method by the author and P. H. Eijkman, give definite information as to every phase. An additional advantage is the ability to dispense with interrupters, and as regards the patient, the absence of preparations to ensure that movement does not take place during the exposure.
L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

273. *Effect of Selenium Cells on Alternating Currents.* **A. Pochettino.** (Accad. Lincei, Atti, 18. pp. 445–451, Nov. 21, 1909.)—The effect produced on the form of an alternating current by introducing a selenium cell into the circuit has been investigated, and results are given, together with curves, for different types of cell. In nearly all cases the wave-form is altered, the area enclosed by one half of the curve being diminished with respect to the other, and the ratio between the difference in areas contained by the two half-waves, and the greater of these, which the author denotes by R, is a measure of the rectifying power of the cell. The value of R varies from 0·06 for a cell with Al electrodes to 0·80 for a Kohl cell of old construction, and in general diminishes with increase in voltage, or decrease in resistance, external influences, such as heat or light, which reduce the resistance, also diminishing R. [See also Abstract No. 1561 (1907).]
W. H. Sː.

274. *Magnetic Field Measurement.* **E. Gehrcke and M. v. Wogau.** (Deutsch. Phys. Gesell., Verh. 11. 22. pp. 664–681, Nov. 30, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—Description of an induction method by which relative measurements of magnetic field intensities can be made with an accuracy of 0·1 in 1000. The method is a null one; two induction currents produced by the two fields to be compared are sent in opposite directions through a sensitive Dubois and Rubens iron-clad galvanometer. The method is applicable to various purposes, but the description is confined to the measurements of fields in iron-free coils. If α_1 and α_2 are the throws of the galvanometer caused by currents I_1 and I_2, and H_1 and H_2 are the fields per unit current in the coils, then $H_1/H_2 = \alpha_1 I_1 A_1/\alpha_2 I_2 A_2$, where A_1 and A_2 are the areas of the coils. Particulars are given of the measurements by which the above accuracy was obtained. In the first case the throws are measured, currents being employed which gave very nearly the same throw. An alteration of the keys in the circuit enables the null method to be employed, the accuracy being greater in this case than in the first. Examples of the application of the method are also given for the comparison of coil areas and currents and for testing the field throughout one of the coils, the same degree of accuracy being obtained in each case. G. E. A.

275. *Determination of Magnetic Induction in Bars.* **C. W. Burrows.** (Bureau of Standards, Bull. 6. pp. 31–88, Oct., 1909.)—It is found that a close approximation to uniformity of magnetic flux along a test rod can be secured by using properly constructed specimens and yokes and properly distributed magnetising coils. The double bar and yoke form of magnetic circuit seems to offer the greatest number of advantages and the fewest disadvantages. The reluctance of the yoke and joints can be kept very small. This is accomplished by having the yokes short and of moderately large cross-section, and making the surface of contact between specimens and yoke of considerable area; the corners of the yokes should be rounded off so as to avoid, as far as possible, disturbing end effects. The magnetomotive force may advantageously be distributed in three sections; a uniform solenoid over the test specimen, a second one over the auxiliary rod, and the third section subdivided into four short coils and placed over the four ends of the rods as near to the yokes as is feasible. These three m.m.f.'s should be capable of independent adjustment and simultaneous reversal. The test coils to be used as indicators should be long enough to avoid errors due to local irregularities due to inhomogeneity of the rods. One coil should be wound under the middle section of each magnetising solenoid and the third should be distributed with one-half over each end of the test bar, but not too near to the yokes. The magnetising force and the magnetic inductance can be measured by zero methods directly from potentiometer readings. A. D. R.

276. *Influence of Oscillatory Discharge and of Magnetisation upon the Elastic Hysteresis for Extension of Iron.* **G. P. Grimaldi and G. Accolla.** (Elettricista, Rome, 8. pp. 329–331, Dec. 15, 1909. N. Cimento, 18. pp. 446–477, Nov.-Dec., 1909.)—The methods of suspending the thin iron wire, of loading it, and of measuring the extension are described. Two loads are put on the wire and the hysteresis is determined from the difference in the reading when loading and unloading. It is found that when an oscillatory discharge passes through a solenoid surrounding the wire the hysteresis is diminished 26 to 86 per cent. With a magnetising field of 9·7 c.g.s. units the hysteresis is diminished 24 to 80 per cent. S. G. S.

277. *Measurement of a Horizontal Magnetic Field.* **J. Revilliod.** (Schweiz. Elektrot. Zeit. 7. pp. 6–8, Jan. 1, 1910.)—A method is described of determining H by vibrating a magnet first in the interior of a closed plane conductor, kept fixed in position, and secondly vibrating magnet and conductor together. By measuring in both cases the period of oscillation and the log. decrement, M and H can be calculated. The reduction formulæ and their proofs are given in the paper. A. D. R.

REFERENCES.

278. *Thermo-electromotive-forces of Metallic Oxides and Sulphides.* **J. Weiss** and **J. Koenigsberger.** (Phys. Zeitschr. 10. pp. 956–957, Dec. 1, 1909.)—The results are given of measurements on the thermo-e.m.f.'s of junctions formed of certain naturally occurring oxides and sulphides with copper. The substances were only obtainable in short rods, and special care was taken to obtain exact measurements of the temperatures at the junctions. J. J. S.

279. *Experimental Confirmation of Principle of Relativity.* **A. H. Bucherer.** (Ann. d. Physik, 30. 5. pp. 974–986, Dec. 14, 1909.)—An answer to the criticism by E. Bestelmeyer of the author's previous work on the above subject. It is here pointed out that the experimental method of the crossed fields which was adopted was derived, not from Bestelmeyer, but from J. J. Thomson. And it is contended, as before declared, that the validity of Lorentz's formula is clearly established. A number of other points are also discussed in detail and the author's position defended. [See also Abstracts Nos. 912, 1936 (1909).] E. H. B.

280. *Mechanical Forces acting on Conducting Bodies in an Electrical Field.* **F. Emde.** (Elektrotechnik u. Maschinenbau, 28. pp. 33–38, Jan. 9, 1910.)—A mathematical discussion of the small forces of electric origin, with hints as to the best way to arrive at a correct estimation of these forces. L. H. W.

281. *Magneto-chemical Researches.* **P. Pascal.** (Annal. Chim. Phys. 19. pp. 5–70, Jan., 1910.)—A more complete account of the work dealt with in Abstracts Nos. 294, 904, 1795, 1947, 1948 (1909).

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

282. *Attempt to Explain the Properties of Radium.* **N. N. Beketov.** (Acad. Sci. St. Pétersbourg, Bull. 18. pp. 879–886, Oct. 1, 1909.)—The chemical behaviour of the elements indicates that their energy-content is very great, and it is probable that the matter of an atom is in a state of continual movement. Although in general the atoms represent very stable systems, yet this internal energy may be the cause of their decomposition, as is the case with radium. In the various series of elements, increase of atomic weight is accompanied by increase of the atomic energy, and this increase is especially great if the atomic volume increases at the same time; consequently, elements with high atomic volumes are extremely reactive. The atomic energy is probably composed of the real chemical energy—which becomes apparent in chemical reactions—and of the energy of movement of the smallest particles composing each atom. On decomposition of the atoms, this energy of movement is converted into other forms of energy, as is observed in the case of radium. T. H. P.

283. *Dynamic Allotropy of Selenium.* **H. R. Kruyt.** (Zeitschr. Anorg. Chem. 64. 4. pp. 305–326, Nov. 17, 1909. Paper read before the "Nederlandsch Natur- en Geneeskundig Congres," Utrecht, April, 1909.)—The specific gravity is used to trace the transformations of selenium. The following allotropic modifications of selenium are distinguished: (*a*) Amorphous vitreous selenium (metastable); (*b*) grey crystalline Se; (*c*) in addition there are two selenium modifications in equilibrium with one another and called by Marc Se_A and Se_B; (*d*) red crystalline Se: a labile form, existing possibly in two modifications. Grey Se that has not been heated above the temperature necessary for crystallisation has a smaller sp. gr. (4·5–4·6) than Se that has been heated above its melting-point (sp. gr. 4·8); the latter on heating at about 125° alters its sp. gr. to 4·77. With rising temperature, the dynamically allotropic transformation ($Se_A \rightleftarrows Se_B$) is towards Se_B and is accompanied by diminution of the specific volume. Under the influence of light the specific volume of selenium increases; there is therefore a displacement of the equilibrium in the direction $Se_B \longrightarrow Se_A$. Elevation of temperature thus acts in the opposite direction to illumination.

D. H. J.

284. *Artificial Sapphires.* **A. Verneuil.** (Comptes Rendus, 150. pp. 185–187, Jan. 17, 1910.)—According to Sainte-Claire Deville and Caron (1858) the red colour of rubies is due to traces of chromium sequioxide, and the blue colour of sapphires to traces of a lower oxide of Cr. But Frémy and Verneuil did not succeed in obtaining sapphires by mixing the chromium oxide with carbon as a reducing agent. Caron also tried iron peroxide and a reducing agent in the oxy-hydrogen blowpipe, which itself was not able to reduce the oxide. The author has produced blue ovoids by fusing in the blowpipe a mixture of alumina, 1·5 per cent. of magnetic iron oxide, and 5 per mille of titanic acid; optically this corundum behaves, according to Wyrouboff, like natural sapphire. That titanium oxide will colour alumina sapphire-blue was noticed by Gintl in 1901, when fusing bauxite in electric furnaces. H. B.

285. *Behaviour of Aluminium in Vacuum Furnaces.* **E. Kohn-Abrest.** (Comptes Rendus, 150. pp. 169–178, Jan. 17, 1910.)—Aluminium of 99·2 per cent., electrically heated in a tube of Berlin porcelain joined to a pump, loses gas and melts to a brilliant regulus, separating from the oxide originally present. At temperatures above 1100° C. up to 48 per cent. of the metal evaporated, chiefly during the first 8 hours. When the metal was heated in a porcelain boat, this porcelain turned an iridescent brown, which might ceramically be utilised. Graphite boats absorbed a considerable portion of the volatilised Al, under formation of black scales of C_3Si_3. Experiments then made with boats of alumina, prepared after Verneuil, proved that the Si, about 14 per cent., was taken up from the porcelain tube. When the metal was fused in a covered crucible of alumina (replacing the boat), no Al was lost and no Si was found after 20 hours of heating; in an open boat of alumina the globules became covered with a yellow film of a silicon alloy. When the porcelain tube was lined with a tube of soft iron, 22 per cent. of Al evaporated in 20 hours, but Si was not found in the metal. H. B.

286. *New Phosphides of Nickel.* **P. Jolibois.** (Comptes Rendus, 150 pp. 106–108, Jan. 10, 1910.)—By dissolving Ni in a mixture of Sn and Sn_4P_3, a crystalline phosphide of Ni is obtained, having the formula NiP_2 and density at 18° 4·62, and losing its phosphorus at 650°. Solution of Ni in a mixture of Sn_4P_3 and SnP_3 gives a second crystalline phosphide of Ni, having the formula NiP_3 and density at 18° 4·19, and losing its phosphorus at 580°.
W. H. Si.

287. *Slow-rusting Iron.* (Eng. News, 63. pp. 6–8, Jan. 6, 1910.)—Contains an account of the development of the manufacture of American ingot iron in the open-hearth steel furnace. In chemical composition and mechanical properties it is very similar to wrought iron. A typical analysis is as follows: C, 0·02; Mn, 0·01; P, trace; S, 0·02; Si, trace; O, 0·03. Its ductility is remarkably high, and tests give an ultimate strength of 47,080 to 49,000 lbs. per sq. in. Its most important quality is resistance to corrosion, this being the object for which it was originally introduced. The ingot iron is manufactured in open-hearth steel furnaces, oxidation being carried out much farther than usual by excessive boiling, a high temperature being used. Limestone and fluor-spar are used for slag production, and ferro-silicon is added as a deoxidiser, metallic Al also being added in the ladle to carry out the dissolved gases. C. O. B.

288. *The System: Hydrogen Chloride and Water.* **F. F. Rupert.** (Amer. Chem. Soc., Journ. 31. pp. 851–866, Aug., 1909.) Pickering has described a trihydrate, $HCl . 3H_2O$, containing 40·33 per cent. HCl, and melting at −24·4°, and a dihydrate, $HCl . 2H_2O$, containing 50·31 per cent. HCl and melting at −17·7°, but no work has previously been carried out on mixtures containing more than 50 per cent. HCl. Experiments are now described in which the remainder of the range from 50 to 100 per cent. HCl has been investigated, the work being carried out under somewhat extreme conditions of temperature and pressure. The author has succeeded in isolating a new monohydrate, $HCl . H_2O$, containing 66·9 per cent. HCl, and melting at −15·35°; this corresponds with a known hydrate, $HBr . H_2O$, of hydrogen bromide. A little beyond this point the liquid breaks up into two layers, the lighter consisting of almost pure HCl, and the heavier of an aqueous solution of the gas. The small solubility of water in liquid HCl is very remarkable, and is

only slightly increased by raising the temperature: the solubility of the liquid HCl in water amounts to about 67 per cent. HCl at —15°, so that the heavier layer consists practically of the melted monohydrate described above, but this solubility decreases as the temperature is raised, and falls to about 58 per cent. HCl in this layer at 50°: at 54·5° the critical temperature of the HCl is reached, and the upper layer becomes gaseous. The author has also determined the density of the liquid and of the saturated vapour of pure HCl from —50° to within a few degrees of the critical temperature, thus:—

	Liquid.	Vapour.	
51°	0·572	0·278	gm. per c.cm.
50°	0·597	0·247	" "
20°	0·839	0·0974	" "
0°	0·929	0·0589	" "
—50°	1·090	0·0125	" "

These figures give a critical density about 0·48 gm. per c.cm. T. M. L.

289. *Chemical Reactions and Ionisation of Gases.* **de Broglie** and **Brizard.** (Comptes Rendus, 149. pp. 923–924, Nov. 22, 1909.)—The authors have continued their investigations [compare Abstracts Nos. 1631, 1632 (1909)], making use of an apparatus similar to that employed by Reboul [Abstract No. 1645 (1909)], and taking precautions to avoid all subsidiary causes of conductivity, notably the formation of layers of conducting dust on the surfaces of the insulators and convection between the plates of the condenser. Under these conditions no conductivity is observed in the formation of either ammonium chloride vapour or nitrous fumes. A very slight conductivity observed in the oxidation of freshly cut sodium is explained by the formation, on the surface of the metal, of a host of microscopic bubbles. To the list of chemical reactions which do not produce ionisation Bloch [Abstract No. 825 (1909)] has added the dissociation of hydrogen arsenide, and the formation of sulphur trioxide by contact, of arsenic chloride without incandescence, and of sulphur chloride. It is concluded that the molecular disturbance due to chemical reaction, when it is not accompanied by the production of high temperature, rupture of the surface, &c., has no tendency to cause ionisation of the surrounding gas. T. H. P.

290. *Absorption of Carbon by Metals, especially Nickel, during the Electrolysis of Aqueous Solutions.* **G. Lambris.** (Zeitschr. Elektrochem. 15. pp. 978–981, Dec. 15, 1909. Contribution from the Anorgan. u. Elektrochem. Inst. d. techn. Hochschule, Aachen.)—The absorption of carbon by nickel when an aqueous solution of an organic acid or its alkali salt is electrolysed is shown to be conditioned by a gas reaction. The gases which are capable of introducing carbon into the Ni are CO_2, CO, and acetylene, all gases which undergo reduction beyond acetylene being devoid of this property. With Pt and Ni oxalic acid is partially reduced to acetylene, but this does not occur with Fe, Cu, or Sn. It is hence concluded that acetylene represents the immediate carrier of the carbon, which exists in electrolytic Ni in the form of a carbide. T. H. P.

291. *Electrolysis with Alternating Current. Dynamic Characteristic of an Electrolytic Cell. Oscillographic Study.* II. **D. Reichinstein.** (Zeitschr. Elektrochem. 15. pp. 913–929, Dec. 1, 1909.)—When such factors as can lead to a large valve-effect, to energy losses, and to condenser effects of a purely physical nature, are excluded, the study of alternating-current electrolysis requires a division of the phenomena into two classes: (1) Phenomena which practically are characterised by the absence of such energy losses as arise from unidirectional electrochemical processes at one and the same electrode, as in the case of the cell Pt—H_2SO_4—Pt, which in the author's experiments evolved no gas. (2) Phenomena which are characterised by unidirectional electrochemical processes at one electrode only. Thus with alternating-current electrolysis the cell Cu—KCN—Cu leads to solution of copper and to evolution of gas. The investigation of the first class of phenomena establishes the validity of the decomposition potential rule for alternating-current electrolysis. The dynamic characteristics lead to a value for the dynamic decomposition potential. The processes in the second class of phenomena can be regarded generally as a competition between the magnitude of the frequency of alternation and some magnitude of chemical kinetics. The dynamic characteristic allows of the value of the loss of energy being determined as an ohmic resistance, and allows also of the determination of the limiting value of the capacity. In the case of all the cells investigated valve-effects of more or less pronounced character were observed. In general, an electrolytic cell can be regarded as a variable condenser with an ohmic resistance connected with it in parallel, and with two resistances (electrolytic resistance and energy loss through valve action) in series with the condenser. The problem of polarisation capacity is closely connected with the problem of electrolytic valves. [See Abstract No. 1133 (1909).] A. F.

292. *Electrolytic Estimation of Tin in Alloys.* **E. Schürmann** and **H. Arnold.** (Königl. Materialprüfungsamt, Mitt. 27. 7 and 8. pp. 470–473, 1909.) *Estimation of Phosphorus in Bronze or Brass in presence of Arsenic.* **E. Schürmann.** (Ibid. pp. 474–476, 1909.)—The alloys were dissolved in tartaric acid and nitric acid and the Cu determined electrolytically. The most successful method for the determination of the tin was found to be as follows: The tin sulphide was dissolved in oxalic acid by prolonged boiling, and not in acid ammonium oxalate as recommended by Classen. The solution was then made alkaline with potassium hydroxide and the tin deposited on a cylindrical gauze kathode, using the Frary apparatus; 0·5 gm. of tin could be deposited in 3–4 hours, using 5 amps. at 5 volts. The major part of the papers deal with ordinary analytical methods. T. S. P.

293. *Electrolysis with Magnesium Kathodes.* **F. Schmidt.** (Elektrochem. Zeitschr. 16. pp. 157–160, Sept.; 189–193, Oct.; 228–232, Nov., and pp. 256–265, Dec., 1909.)—The author has investigated the electrolysis of solutions of sodium chloride, using Pt anodes and Mg kathodes, but no diaphragm. The gas coming from the cell was collected and analysed from time to time in order to determine the amount of hydrogen which had been used up in reducing the hypochlorite formed to chloride. The contents of the cell were also analysed at intervals, the amount of hypochlorite and chlorate being determined. Magnesium is more readily attacked by a solution of an alkali chloride than by pure water, and as soon as the Mg kathode is put into the electrolyte a deposit of magnesium hydroxide is formed on it; this deposit acts as a diaphragm and prevents the hypochlorite coming into direct contact with the kathode, and so being reduced. The result is that there is a quantitative evolution of hydrogen from the cell. The yield of hypochlorite is, however, not quantitative, owing to the secondary formation of chlorate and decomposition of the hypochlorite with the evolution of oxygen. The evolution of hydrogen remains quantitative when high current-densities are used, and is also independent of the temperature (from 0° to 75° C.). The only influence of high current-density and high temperature is that some of the magnesium hydroxide breaks away from the kathode from time to time, but it is immediately replaced by more of the Mg dissolving; the result is that there is a slight excess of hydrogen evolved over that which would be obtained simply by the passage of the current. Alteration in the concentration of the solution from 80 to 10 per cent. resulted only in a slight increase in the amount of chlorate formed and oxygen evolved. The reducing effect of the hydrogen on the hypochlorite was completely suppressed even with as low a current-density as 0·023 amp./cm.^{2}, whereas the addition of chromate to the electrolyte, using Pt electrodes, no longer has a favourable effect at such low current-densities. Of technical importance is the fact that a higher voltage is necessary for a given current when a Mg kathode is used than when the electrode is of Pt, because of the high resistance of the magnesium hydroxide. As the hypochlorite concentration increases the chlorate concentration also increases. In prolonged experiments the hypochlorite concentration finally becomes constant, and also the amount of oxygen evolved, 66·6 per cent. of the current then being used up in the formation of chlorate, and the remainder in the evolution of oxygen. The highest hypochlorite concentration obtained was equivalent to 6·16 gm. of active oxygen per litre, whilst Oettel, using a Pt kathode, obtained 5·78 gm. per litre. Taking everything into consideration, the efficiency of the cell with a Mg kathode is very little better than when a Pt kathode is used. Kathodes of Zn, Cd, Mn, Sb, Britannia metal, and magnalium were tried in place of Mg, but in no case was the reduction of the hypochlorite by the evolved hydrogen prevented. Electrolytes of alkali iodides and bromides gave similar results to those obtained with sodium chloride, except that the efficiency was much increased. In one experiment with a Mg kathode the yield of iodate from an iodide electrolyte was 98·50 per cent., whereas with a Pt kathode it was only 82·69 per cent. A similar suppression of the hydrogen reduction was obtained in the electrolysis of solutions of sodium nitrite and ammonia, but the action of the Mg kathode was considerably affected by the presence of heavy metals as impurities in the electrolyte. T. S. P.

REFERENCES.

294. *The Atomic Weights as Mathematical Functions.* **F. H. Loring.** (Chem. News, 100. pp. 281–286, Dec. 10, 1909.)—[See Abstract No. 1112 (1909).]

295. *Alloys of Nickel and Copper.* **E. Vigouroux.** (Comptes Rendus, 149. pp. 1378–1380, Dec. 27, 1909.)—The author has examined alloys of these metals by chemical methods, and by measuring the e.m.f. set up by the alloys against electrodes of pure Ni or Cu in an electrolyte of normal nickel sulphate. The results show that no compounds are formed in this series. F. C. A. H. L.

296. *Constitution and Heat-content of Lead-Tin Alloys.* **W. Guertler.** (Zeitschr. Elektrochem. 15. pp. 953–965, Dec. 15, 1909. Research Laborat. of Inst. of Technology, Boston.)—Based on the thermal measurements of Spring, the author makes some interesting calculations and deductions on the heat-content, more especially the heat of mixture of lead and tin in the liquid state. F. C. A. H. L.

297. *Electric Conductivity and Density of Solutions of Hydrogen Fluoride.* **E. G. Hill** and **A. P. Sirkar.** (Roy. Soc., Proc. Ser. A. 83. pp. 130–148, Dec. 10, 1909.)